SIMPLE
FAULT TRACING

FOR WIRELESS STUDENTS
AND OPERATORS.

BY

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FOREWORD.

THE contents of this little book have been compiled to assist students of Radio-Telegraphy to obtain their P.M.G. certificates on the standard Marconi apparatus.

During the past eighteen months over 2000 entrants have passed through a course of fault tracing and various tracing systems, tried with varied success by the writer.

The P.M.G. examiners have frequently expressed their desire for the entrant to have a good, sound knowledge of indications of faults, and a fixed method of tracing circuits.

It is useless, therefore, to entertain any idea of trying to clear faults unless the circuits are known thoroughly.

When the circuit can be drawn, the student should learn to trace the circuit verbally; thus for the H.T. closed circuit, right side spark gap to sliding inductance; cross bridge, sliding inductance to jigger primary; jigger primary to left hand back condenser; right hand back condenser to left hand spark gap.

If all circuits are known and traced by this verbal method, no difficulty will be found in tracing the circuits by hand.

On the other hand it is sometimes much quicker to trace a circuit by using the galvo. and cell.

A free use of galvo. and cell must be made at every opportunity.

All switchboards are traced and tested by running from point to point on the front of the board.

Always remember that every circuit must be traced from the source of power.

The system used with the greatest success is contained in this volume.

The D.C. circuit being acknowledged the most troublesome for the inexperienced student, it has been set down as briefly as possible, so that unnecessary time will not be wasted.

It has been observed that in this circuit no mention is made of tracing the armature circuit.

It will be observed, however, that the field circuit cannot be complete unless the D.C line leads are o.k. Therefore the lead from the A terminal of the starter to the positive brush, and the brushes, are the only part of the D.C. armature circuit to be traced, exclusive of the guard lamp leads.

Students entering the fault class for the first time should spend at least two hours trying all the indications, and learning to trace circuits by hand and by galvo. and cell.

When students are conversant with the set,

faults may be cleared as set down in the following pages.

Operators at Sea.—Operators when at sea, are liable to forget the essentials for quick tracing of faults, which so seldom occur on the standard Marconi set.

The fault may be located in the same way as tracing and clearing faults for examination purposes.

Faults at sea usually arise through neglect and bad insulation, caused by excessive dampness.

A noted receiving fault being the telephone leads short-circuited, through the cotton insulation becoming wet or very damp.

Practical Diagrams.—The diagrams are connections of circuits which students have found to be the most difficult to remember, and a large percentage of entrants have failed through wrongly connecting the part of the circuit shown.

FAULT TRACING.

Marconi 1½ K.W.—Fixed and Rotary Sets.

D.C. Circuit.—The indications given at the starter or main switch are usually known as bright arcs and thin arcs. The arcs given at the starter vary slightly in colour when a D.C. guard lamp is in or out of the circuit. For this reason no colour name should be given to the arc.

A bright arc is one which flashes across the eyes. A thin arc is one which has no effect upon the eyes. If a control switch is fitted, examine the fuses and see that the switch is closed, then examine the main switch fuses and jaws. If main switch fuses "blow" when switch is closed look for short circuit directly on the front or back of switch, starter (L and A leads shorted) and marine board. If fuses hold, bring starter handle to top of first active stud and hold without advancing (unless motor starts up properly), for 2-3 seconds. If motor does not rotate or does not rotate properly, let handle go and note if any indication is given.

Indications.—No indication given at the starter or main switch, denotes a break in both A and

F circuits. Trace the F circuit first, starting at the no-volt release, middle terminal of starter to either side of the regulator (while at the regulator, see that contact handle is on the small studs and pointing to the right), other side of the regulator to the field pole, other side of the field pole to the negative or line brush terminal. The reason for tracing the F circuit first is that unless we have a field circuit we will not get the indication that the L lead of the starter is on the A terminal of the starter (L and A crossed on starter).

Main Switch Indications.—Bright arc:—(*a*) L and F crossed on starter; (*b*) accumulators on charge. Thin arc:—(*a*) L and A crossed on starter; circuit through field o.k.

Starter Indications.—Bright arc:—(*a*) F circuit broken; (*b*) short circuit on D.C. brushes, guard lamp, or L and A leads between the starter and the brushes. Thin arc:—(*a*) break in the armature circuit.

Guard Lamp Indications.—If D.C. guard lamp lights up but motor does not rotate, it indicates that current is flowing to the lamps from where the lamps are tapped from the L and A leads, but this indication must not be used unless an indication is given at the starter at the same time as when the lamp lights up.

If an indication is given, the brushes and the armature leads, from the positive brush terminal to the cable connector, may be examined. It is not necessary to trace the line lead in this case because the line is part of the field circuit.

Complex D.C. Faults.—Motor starts when main switch is closed and starter handle in off position:—(*a*) L and F leads of starter shorted, thus connecting starter handle to top stud and cutting out no-volt release; (*b*) D.C. (or A.C.) brush "earthed." If starter handle will not hold over examine (*a*) no-volt release shorted, core taken out, soft-iron armature on starter handle, too much tension on spring of starter, too much resistance in the F circuit, L and F shorted on starter.

MOTOR RACING.—Too much resistance in the field, examine regulator, return F lead from field pole connected to a positive instead of a negative brush.

SPARKING AT THE BRUSHES.—Tension on the brushes, uneven spring adjustment, rocker adjustment. Main fuses blow when starter handle brought to the first stud: starting resistance shorted, or when coupled with the no-volt release, smoking or fusing usually indicates that the armature circuit is connected to the field circuit.

ARMATURE SHORT-CIRCUITED.—Motor revolves with a slow, spasmodic motion; four jerks to the revolution. This fault can be placed upon the commutator but usually is placed upon the A.C. side, and is known as a "short on the slip rings." This fault must be traced out from the slip rings, A.C. guard lamp, etc., to the pilot lamp, and if the A.C. switch is closed, across the Iolanda board or the L.F.I.C.I. and transformer primary leads.

REVERSING ROTATION OF MOTOR.—Change L and A leads at the cable connectors (where guard lamp is tapped off), and change the "return field lead" to the new negative brush.

D.C. GUARD LAMP LIGHTS WHEN MAIN SWITCH IS CLOSED.—L and F reversed on starter, break in armature between starter and brushes (F circuit broken will give same indication if L lead on F terminal.

A.C. Primary Circuit.—When a converter is running properly, the next step is to get the pilot lamp alight.

Adjust the brushes, and make sure that the leads from the slip rings to the A.C. switch are connected to adjacent terminals of the slip rings, and that the A.C. guard lamp is connected. Trace leads to the A.C. switch and thence to the lamp. The lamp holder must be

properly fixed, so that the contact prongs are at right angles with the slots. When the pilot lamp is alight, the A.C. fuses must be examined and tested with a cell and galvo., and the A.C. switch closed to obtain an am'meter reading.

To obtain Am'meter Reading.—Remove am'meter plug, close A.C. switch and press key, if no reading is given there is a break in the circuit. If fault is suspected behind the board, test from point to point with a galvo. and cell.

Tracing the Primary Circuit.—FIXED GAP SET. -After testing fuses, trace the circuit in the following way. Left hand lead to the L.F.I.C.I., L.F.I.C.I. to the key; connect key and magnetic key —magnetic key to the primary of the transformer, connect the primaries in parallel, transformer primary to the right hand side of board.

ROTARY SET.—After testing fuses, trace circuit, starting from the left hand lead through the key, magnetic key, L.F.I.C.I., primary of transformer, to the right hand terminal of the A.C. board.

General Faults on the Circuit.—L.F I.C.I. For general faults purposes, all the L.F.I.C.I. is put into the circuit, thus often causing a lag and indicated by the motor speeding up when the key is pressed. It must be remembered

that a faults set has fifteen amp. fuses in the main switch instead of the standard fifty amp. fuses. If, however, a diagram is supplied with the set, the connections must be made according to this diagram. By placing all the L.F.I.C.I. into the circuit the current, and therefore the amp. reading, is kept low.

KEY AND MAGNETIC KEY.—If an amp. reading, or a spark (or arc), is obtained directly the A.C. switch is closed, and without keeping the key depressed, the fault lies upon the key or magnetic key, the connections, or adjustments. It is advisable to remember that, when using a parallel key, the top right terminal is a so-called dummy terminal, and nothing should be connected thereto.

TRANSFORMER PRIMARY.—The Iolanda type of transformer is connected in series and parallel externally. If the leads are touching or in any way causing a short circuit, a high amp. reading will be obtained, which must not be confused with the high amp. reading given when the secondary of the transformer is short circuited. It is therefore advisable to disconnect the secondary from the choke, thus putting the secondary "off lead," so as to ascertain whether the primary is working normally. A low amp. reading shows that the primary cir-

cuit is correct, and the secondary of the transformer is off load.

A very low reading, when using an Iolanda type of transformer, sometimes indicates that one of the primaries is disconnected.

High-Tension Circuit.—The indications of this circuit are as follow:—Low amp. reading: primary circuit correct, secondary of the transformer "off load" (which is not necessarily the secondary disconnected). High amp. reading and no spark or arc: short circuit on the secondary of the transformer, in any part of the circuit (provided there is not a short circuit on the primary of the transformer).

Arc obtained instead of spark at discharger: condenser disconnected.

If there is a short circuit upon this circuit, the whole circuit must be traced by commencing directly at the secondaries, and continuing through the chokes to spark gap. Spark gap, sliding inductance, jigger primary, condenser, back to the other side of the spark gap The chokes may be short circuited if broken beyond a quick repair.

If an arc is obtained, showing the secondary of the transformer discharge, the circuit must be traced by commencing at either side of the spark gap, and running through the circuit in

the same way as tracing for a short circuit.

Open Circuit.—A simple series circuit, traced out starting from the aerial and finishing at the earth arrester. The tuning lamp will not glow unless the aerial or condenser (substituted for an aerial) is in the circuit.

Changing Wave Length.—450 metre wave.—Cut out one bank of the main condenser, re-adjust spark gap and inductance according to diagram. 300 metre wave. —Connect secondaries of transformers in series, main condenser in series, re-adjust spark gap, adjust sliding inductance to the diagram. Connect Bradfield directly to the jigger secondary, thus cutting out the A.T.I., and insert the short wave condenser, one side to the Bradfield and the other to the top plate of the separate earth arrester.

Spark Gaps.—There is no fixed distance for sparking. The fixed gap must be adjusted to obtain the best spark, no matter how large or small the gap may be made, when working power, plain aerial, or tuned emergency. The rotary gap for power working is adjusted to as near the studs as possible. For working tuned emergency one electrode must be screwed down and the other adjusted to give a good spark.

The Emergency Set.—First place all switches of the marine board to the "off" position (a vol-

tage will be obtained if the bottom fuse is taken out of the marine board, and the double-pole switch placed into circuit). This reading will be the main supply voltage.

When switches are off, the fuse may be placed across the bottom middle terminals.

No volt reading: disconnection on accumulators or board. Insufficient voltage: accumulators connected wrongly. If one accumulator is wrongly connected the voltage drop will be four.

If no voltage is obtained, and the marine board has been tested and found all correct, the two right hand leads may be traced to the accumulators and the disconnection repaired. A disconnection may be either a total disconnection or the insulated part of the lead wrapped round the terminal. Insufficient voltage may be traced by the same method. If the middle right hand lead is connected to the positive pole of the battery, the outer right hand terminal must be connected to the negative pole of the battery.

The leads from the board to the coil may be traced when correct voltage is obtained.

Connect primary leads, base condenser, key, and the secondary should be connected to the discharge rods before the switch is placed into circuit.

Adjust the hammer break without putting any tension upon the spring. Switch may now be thrown over, and, after the commutator has been placed in position, the key depressed once.

No arc at key when lifted, or no motion of hammer break: break in coil primary circuit.

If there is a break in the primary circuit the circuit must be retraced from the marine board.

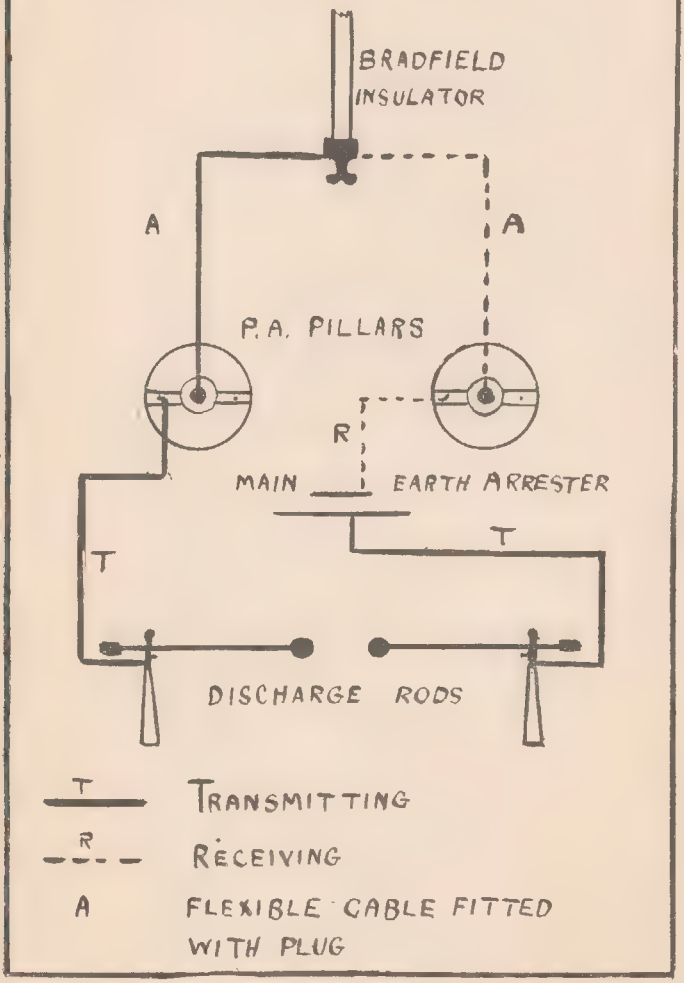
Excessive and muffled arcing at the hammer break, with only a slight tendency to spark or arc at the discharge rods, denotes the base condenser is out of circuit—either the pins disconnected or not screwed down tightly. A faulty or punctured condenser will usually cause the bottom fuse to break. The indication is usually that the hammer is attracted once to the core, then the fuse blows. The key will therefore be short circuited, and the hammer attracted directly the commutator is thrown into circuit.

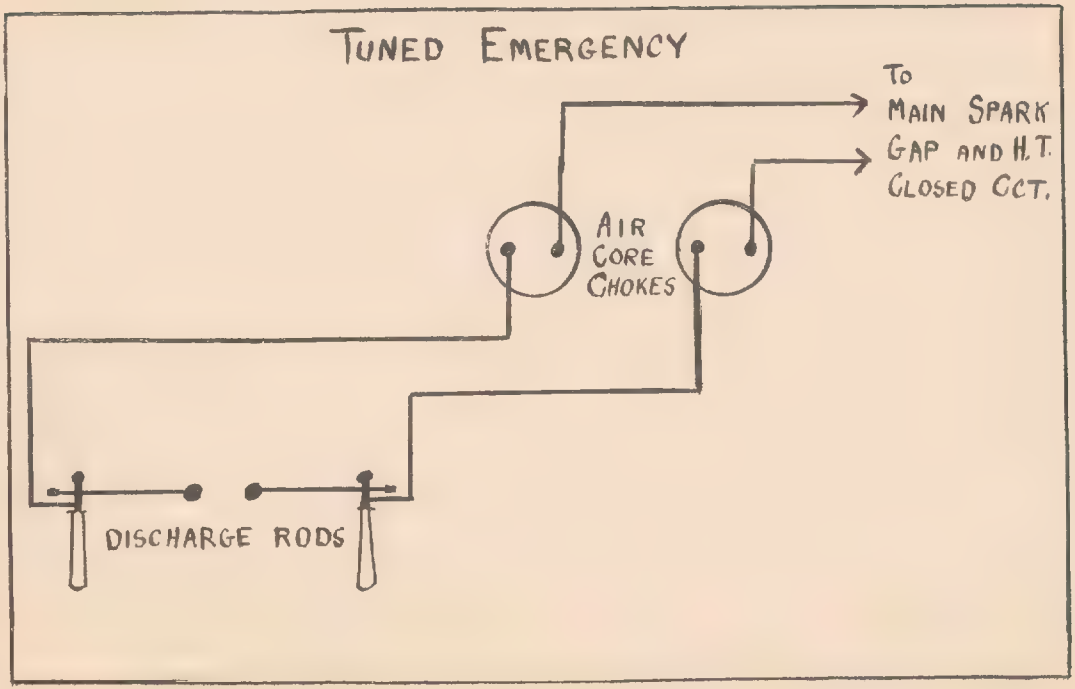
The extra condenser, when working the coil from the mains, is connected directly across the hammer break.

A slow continuous vibration of the hammer is caused by a partial or direct short circuit upon the secondary of the coil. The slow vibration may be made more marked by making a loose adjustment of the break.

No tension is needed on the hammer break

Plain Aerial (P.A.)




TUNED EMERGENCY
To
MAIN SPARK
GAP AND H.T.
CLOSED CCT.
AIR
CORE
CHOKES
DISCHARGE RODS

unless it is necessary to increase power.

Arc or spark obtained on release of key instead of arc or spark when key being depressed: hammer break requiring adjustment; if key is kept pressed the fuse will "blow."

Plain Aerial and Tuned Emergency.—Unless a condenser is across the coil secondary the discharge will be an ordinary arc. A normal vibration of the hammer and no tendency to arc indicates that a condenser is across the coil secondary, and therefore the gap must be reduced until a good spark is obtained.

Plain Aerial Connections.—Until plain aerial (or tuned emergency) connections are made the discharge should be non-oscillatory. For plain aerial there must be only one lead from the Bradfield; the lead which plugs into either the transmitting or receiving pillar.

TRANSMITTING.—One side of discharge rods to the transmitting pillar, thence to the aerial. The other side of the discharge rods to the bottom plate of the main earth arrester, to earth.

RECEIVING.—Change the flexible lead from the transmitting to the receiving pillar. The receiving pillar being connected to the top plate of the main earth arrester.

Tuned Emergency.—Connect the secondary to the chokes in place of the transformer secon-

dary leads, re-adjust spark gap. Arc at discharger instead of spark gap: trace as for power set. Slow vibration of hammer: short circuit on secondary of coil or high tension circuit. Normal vibration of hammer and no spark: spark gap too wide.

General.—If plain aerial was connected and another lead was run from the Bradfield to the A.T.I., jigger secondary to the earth arrester, the hammer would vibrate slowly (indicating a short circuit on the secondary), caused through placing the earth arrester across the secondary.

If, on the other hand, the short wave condenser was connected, the condenser would be placed across the secondary, and a small oscillatory spark only would be obtained at the discharge rods.

Tuned emergency faults, and the tracing of the faults, are practically the same as when using the power set, only the indications are different, excepting in the case of an arc being obtained instead of a spark.

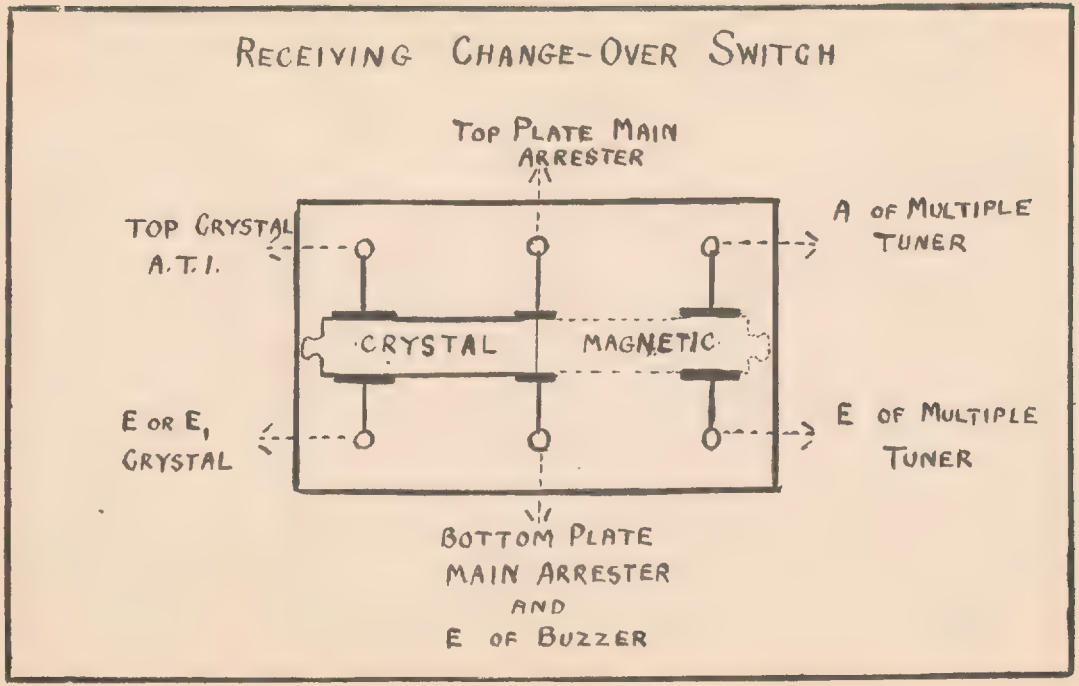
Receiving Sets.—The buzzer must be connected first. When the buzzer is working the A and E terminals are connected as follows:—CRYSTAL (sparking buzzer or shunted buzzer). —A to limp aerial; E to bottom middle c/o switch or direct to earth arrester. MAGNETIC

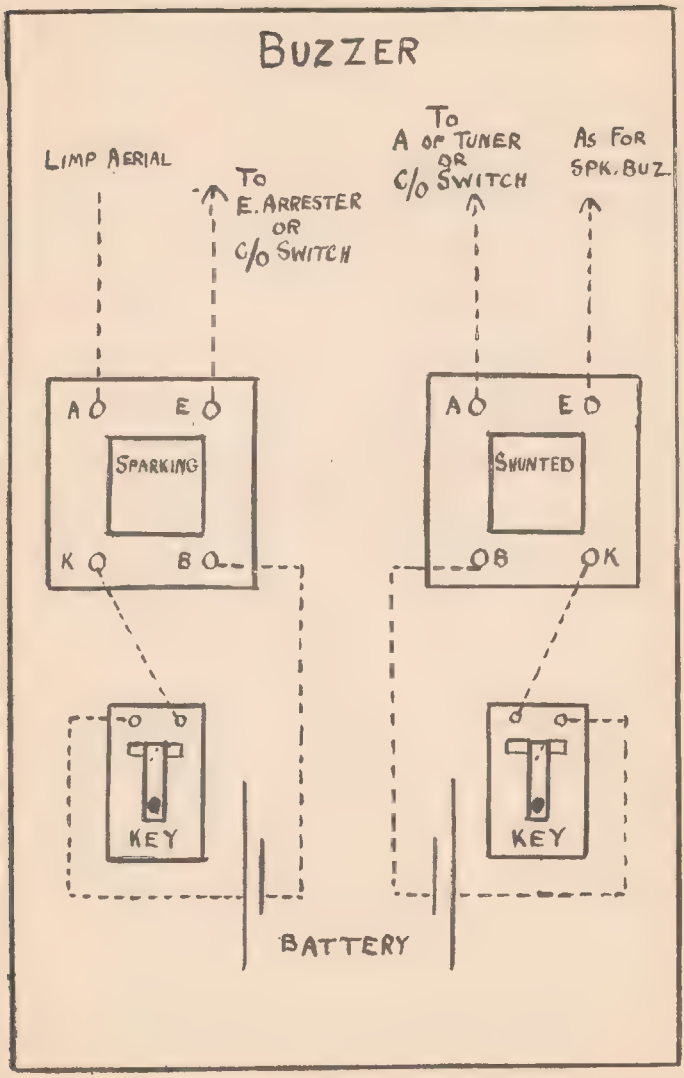
DETECTOR.—Sparking buzzer, same as for crystal; shunted buzzer, A to A of tuner, E as for crystal. In both cases the buzzer earth is connected either directly to the earth arrester, or to the bottom middle of the change over switch. The latter is used when both crystal and magnetic detector are fitted.

When buzzer is connected, trace leads from the main earth arrester to the A and E terminals of the tuner, or, in the case of using a c/o switch, to the top and bottom middle terminals.

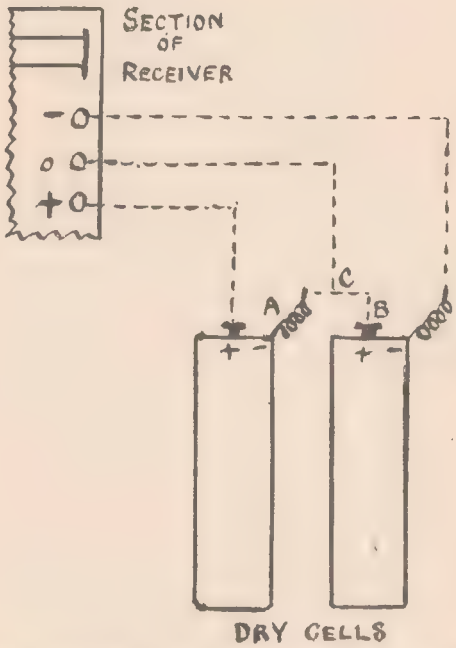
The c/o switch must now be put into the circuit, and to the proper side for practical reception. Buzzer signals may be obtained without closing this switch, but practical signals will not be heard unless the switch is closed. Any connections on the receivers must be carefully checked. When both crystals and magnetic receivers are fitted, low resistance telephones are usually supplied. The resistance of the phones is usually marked by the makers, by placing the resistance on the side support of the ear pieces—thus 6000, means 6000 ohms resistance. A1 is also used for classifying high resistance phones. Both high and low resistance phones may be sunk in insulating material, but usually the high resistance have the addition of sparking points.

Receiving Change-Over Switch




BUZZER
LIMP AERIAL
To
E. ARRESTER
OR
C/O SWITCH
To
A OF TUNER
OR
C/O SWITCH
AS FOR
SPK. BUZ.
A
E
SPARKING
K
B
A
E
SWUNTED
B
K
KEY
KEY
BATTERY

CRYSTAL BATTERY



THE NEUTRAL (o) LEAD MAY BE TAKEN FROM TERMINALS A OR B, OR TAPPED OFF C.

TESTING.

Crystal.—The jigger primary may be tested by placing the galvo. and cell across the A and E terminals. The rest of the closed circuits must be tested from point to point.

The crystal, telephone transformer, and telephones may be tested by making and breaking the battery or crystal switch. A click will be given in the telephones on breaking contact. The potentiometer battery should give a galvo. reading of not less than twenty-five.

The telephones may be tested by making and breaking contact across one dry cell.

The telephone transformer secondary may be tested with a galvo. and cell. The primary with cell and phones in series.

Magnetic Receiver.—Galvo. test from A terminal to aerial side of A.T.C., earth side of A.T.C. to E terminal of the tuner.

The primary and secondary of the detector may be tested by the galvo., or testing the magnetic detector and phones by tapping the iron band, causing a variation of the magnetic field by the mechanical jar. In the latter test a click will be heard in the telephones.

General.—Faults upon the receivers are usually composed of wrong or dirty connections. All micrometer gaps should be examined to ascertain whether any foreign matter is causing a short circuit. The short circuiting springs, connected across the telephones, must always be examined from the main key to the telephone terminals of the tuner. All sliding contacts must be kept clean and making fairly even contact.

POWER SET.

The following may be tested with a galvo. and cell: starter, regulator, switchboard, L.F.I.C.I., keys, transformer, primary, jigger, chokes, A.T.I., tuning lamp, sliding inductance.

Main Switch.—Test lamp across top jaws of switch for main power, bottom terminals for fuses, across L and A leads of starter for current delivery to starter.

Converter.—Armature: not practicable without use of "megger" or millivoltmeter.

Field: galvo. and cell.

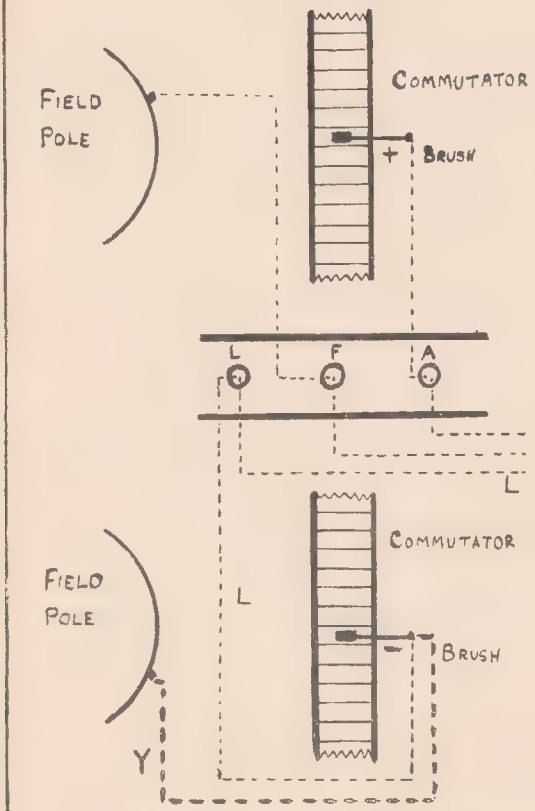
Guard Lamp.—Across main switch. Slight reading given with galvo. and cell.

Condenser Main and Short Wave.—Test each bank separately, then both banks in series and parallel. Place condenser across secondary

of coil. A slow vibration of the hammer indicates a short circuit in the condenser. The broken plates may be observed by arcing in the broken part of the bank. If condenser is o.k. a small oscillatory spark will be given at the discharge rods. The transformer may be used in place of the coil if desired.

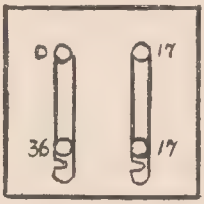
Transformer Secondary.—Test with cell and telephones in series.

Converter Connections, D.C.

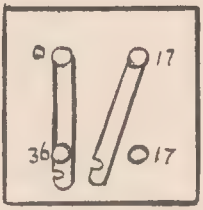


Y — Return Field Lead; Always Connected To Same Brush As Line Lead (L).

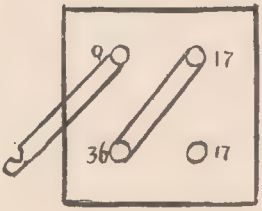
Main Condenser



Parallel
600
metre
wave

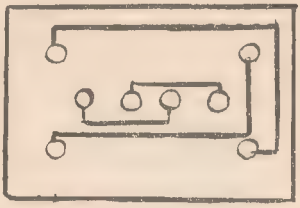


one bank
420
metre
wave

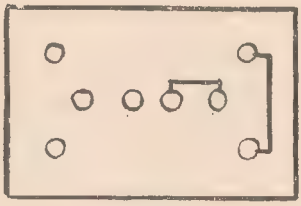


Series
300
metre
wave

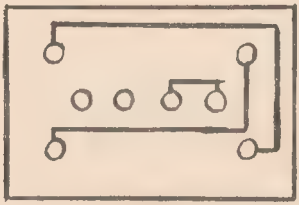
IOLANDA TRANSFORMER



PARALLEL



SERIES



USUAL CONNECTIONS
FOR
300 METRE WAVE